THE STRATIGRAPHICAL ARRANGEMENT AND OCCURRENCE OF TORBANITE DEPOSITS IN THE UPPER KAMILAROI COAL MEASURES OF NEW SOUTH WALES.

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(Plate iv; three Text-figures.)

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GENERAL NOTES ON MODE OF OCCURRENCE.

The occurrence of torbanite in New South Wales was described by J. E. Carne (1903) in a Memoir of the Geological Survey. Since then a considerable quantity of data has been recorded by members of the Geological Survey, and included in the Annual Reports of the Department of Mines; a list of these is given at the end of this paper. For the general stratigraphy of the Kamilaroi, reference should be made to Memoirs of the Geological Survey, and Annual Reports of the Department of Mines, N.S.W. An unpublished D.Sc. thesis by H. G. Raggatt (University of Sydney, 1940) contains a full and comprehensive treatment of the stratigraphy of the Kamilaroi Basin. The detailed stratigraphy of the western portion of the Upper Coal Measures, to which reference is made in this paper, has been reviewed by the author in a previous paper (Dulhunty, 1941*b*).

On the western margin of the basin the Upper Coal Measures alone are represented; and it is probable that no more than the top portion, or Newcastle Stage, is present. It was suggested by the author that the upper limit of the coal-measures should be taken at the top of the No. 1, or Katoomba Coal Seam, and the lower limit at the base of a thin bed of *Glossopteris*-bearing shales which occurs immediately below the lower member of the Marangaroo Conglomerate. Four major coal-bearing horizons can be identified at most places along the western margin of the Kamilaroi Basin. These consist of the Katoomba Seam at the top of the measure, the Dirty Seam occurring 60 to 100 feet below the top, the Irondale Seam at about 80 to 120 feet above the base, and the Lithgow Seam, which occurs between the upper and lower members of the Marangaroo Conglomerate near the base of the coal-measures.

Thirty separate deposits of torbanite are known to occur in the Upper Coal Measures outcropping along the western margin of the Kamilaroi Basin, and four occurrences have been recorded from the Greta or Lower Coal Measures. The latter are situated at Murrurundi, Muswellbrook and Greta on the northern side of the basin, and in the valley of the Clyde River on the southern side. The torbanites of the Upper Coal Measures outcrop on the steep sides of valleys which have dissected the Triassic sandstones and underlying coal-measures, exposing in many places the Upper Marine Beds, and in some places the pre-Carboniferous basement rocks.

The accompanying geological map (Plate iv) illustrates the general distribution of Upper Coal Measure strata, and the occurrence of torbanite deposits along the western margin of the Kamilaroi Basin.

The deposits occur interbedded with the coal-measure sediments as isolated lenticular seams whose lateral extent varies from as much as six miles to less than half a mile. The known outcrops represent deposits which have been dissected during the development of the valleys, and many have been almost completely removed, while others have suffered comparatively little erosion, leaving considerable areas of the thickest portions *in situ*. There is little doubt concerning the existence of many additional deposits along

the western margin of the Upper Coal Measures, where extensive areas, covered by Triassic sandstone, have not yet been dissected by the development of valleys. Mort's Megalong Seam, near Katoomba, forms an excellent example of a deposit almost completely removed by valley development. Its eastern margin remains *in situ* under Narrow Neck Range, and a small section of its north-western margin is present at the West Head of Nelly's Glen, the central and south-western portions of the deposit having been removed during the development of the valley of Megalong Creek.

The Baerami occurrence constitutes an example in which the greater part of the deposit still remains *in situ*. Widden Brook and Baerami Arm Creek have exposed the western and eastern margins, respectively, and Reuben's Gully has dissected the central portion of the deposit, but its narrow gorge has removed comparatively little torbanite.

The majority of the known deposits have been reduced, by erosion, to half their original size, or less. It has been suggested that this may indicate some relation between the distribution of deposits and the pattern of the present drainage system. There is no conclusive evidence of any such relation. A possible explanation is that the chances of forming an outcrop along the existing valley walls are much greater for the deposits whose central portions originally occurred within the area of the valleys than those whose central portions lie behind the valley walls. The deposits outcropping in the Capertee Valley and its tributaries may be taken as an example. Three deposits, Blackman's Crown, Mornington and Mount Marsden, have been more than half removed by erosion, while two, Airly and Wondo, are approximately half dissected, and one, the Glen Davis deposit, is less than half removed.

The deposits may be described as generally lenticular, thinning in all directions towards their margins, but there is a tendency to thin out more rapidly at the edges than in the central portions. If it is assumed that the deposits originally accumulated in small lakes, rapid marginal thinning would be expected near the shore lines. The actual edge of a deposit is usually indefinite, as the thinning is frequently accompanied by reduction in the quality and lateral transition into carbonaceous shale, cannel coal or bituminous coal.

A belief is held by many practical miners that all torbanite deposits thin out immediately they pass under the cliffs of sandstone formed by the Triassic rocks overlying the coal-measures. There is, of course, no relation between the lateral extent or marginal thinning of a deposit and the position of the sandstone cliffs, as the former features were determined in Permian time before the Triassic beds were laid down, and the existing topography is a result of comparatively recent erosion.

Many deposits do thin out when followed by mining operations beneath the sandstone cliffs, but this is a consequence of their limited lateral extent, and the fact that the majority of deposits have been more than half removed by erosion during the development of the valleys.

THE ASSOCIATION OF TORBANITE WITH BITUMINOUS AND CANNEL COALS.

Torbanite is essentially a sapropelic material, and the deposits occur in association with fine-grained argillaceous rocks, carbonaceous shales, cannel coal and bituminous coal of freshwater origin. Cannel coal and carbonaceous shale, together with all gradations between the two, invariably occur in close association with the torbanite seams, and frequently form irregular beds of small lateral extent, similar to the torbanite itself. The seams of bituminous coal may also be thin and irregular, but they usually constitute beds of more uniform thickness, extending over much larger areas than the torbanite and cannel coal seams. This is essentially the case when the torbanite is associated with one of the major coal-bearing horizons, on which the coal-seams can be traced far beyond the limits of the torbanite. The intimate association of cannel coal with torbanite is particularly important, as the two materials appear to be products of the same environment, but derived from different types of organic debris. In the present paper, the term cannel coal is applied to coaly substances of compact and homogeneous nature, with black streak and inconspicuous cleat, containing a volatile content lower than the percentage of fixed carbon.

The cannel coals may occur either above or below the torbanite seams, and frequently as interbedded bands. Some deposits are of a composite nature, exhibiting alternating bands of torbanite and cannel coal. The Wollar occurrence is an outstanding example of this type, containing eleven bands of cannel coal and twelve bands of torbanite. The cannel bands are usually in contact with the torbanite, although thin clay or shale partings are not uncommon. The planes of contact between the torbanite and cannel are normally sharp and well defined; but transition zones between the two materials have been noted in several cases.

The cannel bands occurring at the edge of a deposit may change gradually to torbanite as they pass towards its centre, while those situated near the centre are usually lenticular, thinning out at their margins rather than changing laterally to torbanite. The cannel bands interbedded with torbanite, vary in thickness from a fraction of an inch to several feet—their aggregate thickness frequently amounting to more than that of the torbanite.

Bright bituminous coal and splint coal are also common associates of torbanite; but they do not exhibit the intimate association typical of cannel coal, and rarely occur as interbedded components of the seams. These coals may be situated either above or below the torbanite, and are usually separated from it by clay shale or cannel bands. In some deposits, however, the torbanite is actually in contact with bituminous coal, and gradual transitions, both vertical and lateral, between the two materials have been observed in several deposits. The bituminous coal lying in contact with torbanite is characteristically bright and clean, consisting mainly of vitrain, while the seams which are separated by cannel or clay shale are often dirty, containing much durain and possessing high ash contents. The sections, shown in Fig. 1, illustrate the general mode of occurrence of torbanite and its association with cannel and bituminous coal. Sections of a similar nature were measured by Carne (1903), and others have been recorded in the Annual Reports of the Department of Mines, N.S.W.

Section 3 of Mort's Upper Seam in the Megalong Valley shows bright, bituminous coal in contact with the upper surface of the torbanite. At Crown Ridge (Section 1), bright, bituminous coal occurs between two torbanite seams, but separated from them by cannel coal, while at Glen Davis (Section 2), bituminous coal occurs both above and below the torbanite, from which it is separated by thin clay and carbonaceous shale bands. Sections 1, 2, 3 and 5 illustrate cannel coal in contact with torbanite, both above and below the seams and interbedded without partings in the case of the Glen Davis deposit.

Certain portions of the Ruined Castle Seam (Section 4), in the Jamieson Valley, exhibit the unusual features of sandstone lying directly in contact with torbanite, and the absence of bituminous coal. A similar occurrence was reported at Joadja by Carne (1903), where sandstone forms both roof and floor to 15 inches of torbanite on the south-eastern margin of the deposit. All the torbanite deposits in New South Wales are modifications of the sections shown in Fig. 1.

RELATIONS BETWEEN TORBANITE-BEARING HORIZONS AND COAL-MEASURE STRATIGRAPHY.

In studying the arrangement of the torbanite deposits in the Upper Coal Measures, it is necessary to adopt a method by means of which the relative stratigraphical positions may be investigated. The persistent coal-bearing horizons, referred to in the introduction to this paper, may be taken as specific surfaces of sedimentation, and relied upon as planes of reference, but the variations in total thickness of the coal-measures and the intervals between the coal-bearing horizons cause difficulty in correlating the horizon of torbanite deposits which are not associated with the major coal seams. Carne (1903) attempted to illustrate the relative vertical positions of the deposits by arranging them in order of their height above the Marangaroo Conglomerate, and indicated seven groups of deposits. This method could be used for correlating seams in a confined area where variations in the total thickness of the coal-measures would be negligible, but it does not allow for large variations in thickness over wide areas. For example, horizons 60 feet above the Marangaroo Conglomerate could not be correlated in areas

in which the total thickness of the measures varies from 250 feet to 500 feet. The coal-measures actually vary in thickness from 535 feet in the Capertee Valley near Glen Davis to 250 feet at Tong Bong Mountain, and as little as 125 feet at several places along their margin in the Joadja-Burragorang district.

There is no difficulty in correlating torbanite deposits which occur on the horizons of the major coal seams, but many are situated at various positions between these

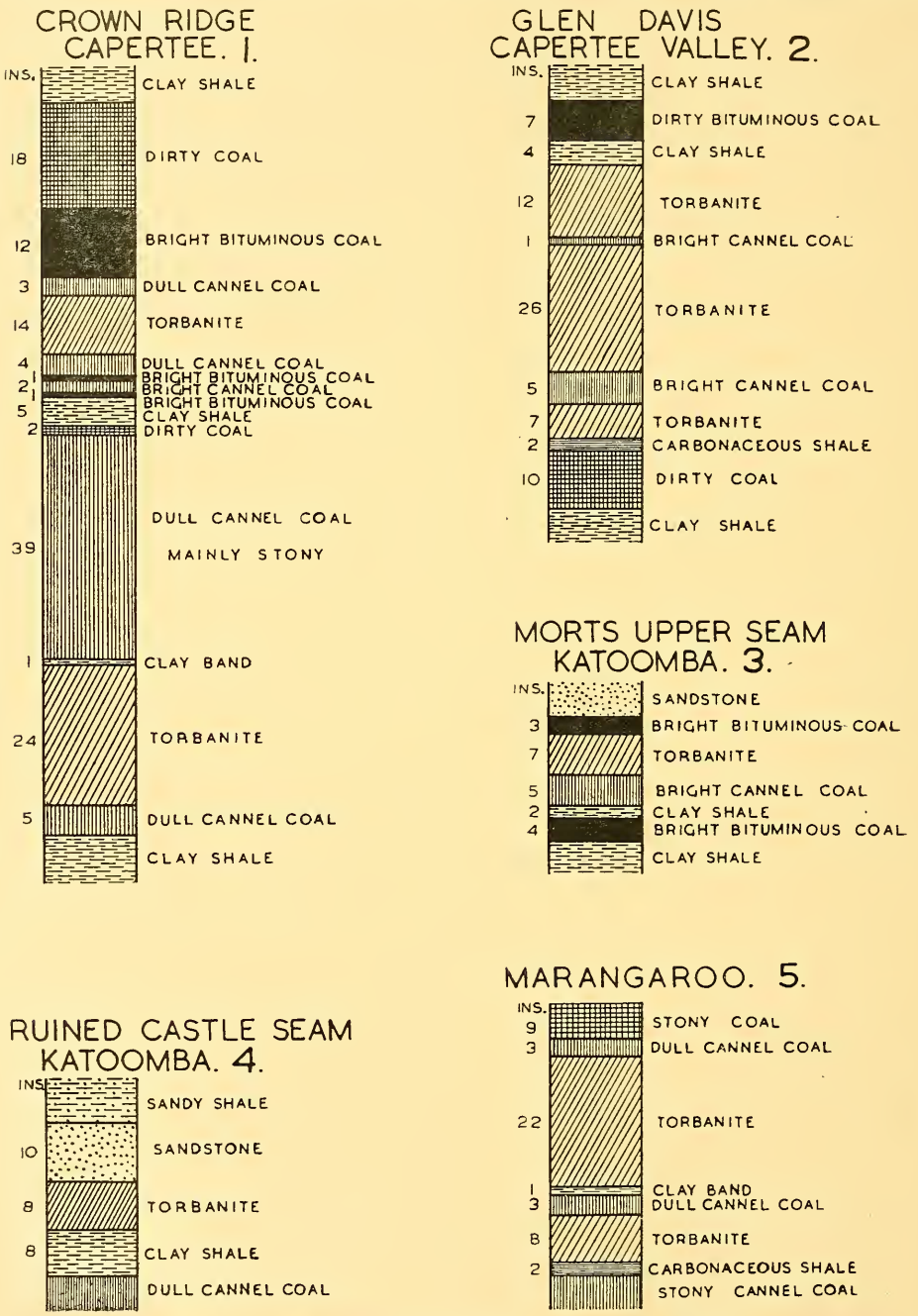

Fig. 1.—Sections illustrating the mode of occurrence of torbanite in New South Wales.

seams. It is considered that a method of correlating the torbanite-bearing horizons and examining their arrangement in the coal-measures should be based on the positions which they occupy in relation to the major coal seams. With this object in view, the diagram shown in Figure 2 has been prepared, in which a vertical columnar section

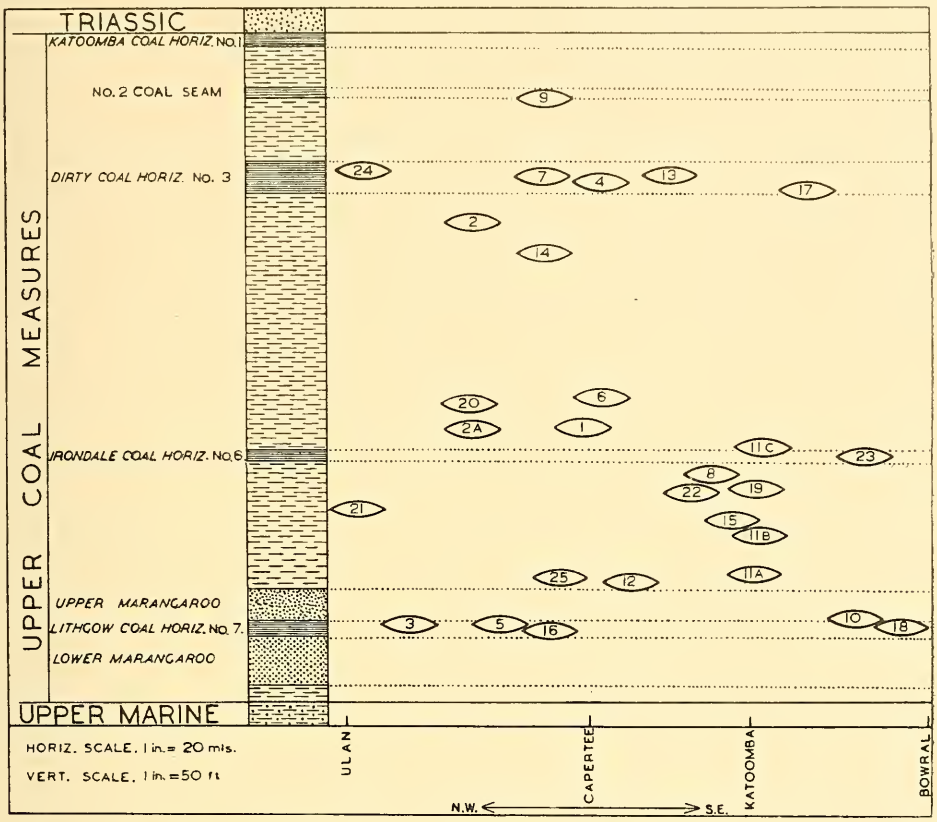

Fig. 2.—Diagram illustrating the vertical and lateral distribution of torbanite deposits in the Upper Coal Measures between Ulan and Bowral.

1. Airly.
2. Baerami.
2A. Baerami Lower.
3. Barigan.
4. Blackman's Crown.
5. Coolaway Mountain.
6. Glen Davis.
7. Grimshaw's Seam.
8. Hartley Vale.
9. Ilford Range.
10. Joadja.
11. Katoomba—
    (A) Mort's Lower.
    (B) Mort's Upper.
    (C) Ruined Castle.
12. Lamb's Seam.
13. Marangaroo.
14. Mornington.
15. Mt. Blackheath.
16. Mt. Marsden.
17. Tonalli.
18. Reedy Creek.
19. Sugar Loaf Mountain.
20. Tong Bong Mountain.
21. Ulan.
22. Victoria Falls.
23. Wanganderry.
24. Wollar
25. Wondo or Cottage Rock.

represents the average conditions which prevail in the coal-measures, including total thickness and the relative positions of the coal seams, while the base represents the outcrop of Upper Coal Measures from Ulan south-east to Bowral. Each torbanite deposit has been allotted a position on the diagram depending on its relative stratigraphical position between the two nearest coal-bearing horizons, and its geographical situation determined by projecting its position on to a straight line between Ulan and Bowral. The arrangement of deposits on the diagram is independent of variations in the total thickness of the measures, and errors, due to irregular rates of change in the vertical intervals between the coal seams, are also reduced to a minimum.

It will be noted that the upper stratigraphical limit to the occurrence of torbanite is the No. 2 Coal Seam near the top of the coal-measures, and the lower limit is the Lithgow

Coal Seam near the base of the measures. Certain regions in this column contain numerous deposits of torbanite, while others do not contain any at all. Of the twenty-eight deposits shown on the diagram, thirteen occur on the horizons of major coal seams, nine are situated close to these coal seams, and six occur more or less at random in the coal-measures between the major coal seams. The Dirty and Lithgow Coal Seams are the most prolific horizons, each yielding five deposits, then comes the Irondale Seam yielding two, the No. 2 Seam one and Katoomba Seam none. There is also a tendency for torbanite to occur near the coal-bearing horizons. Certain portions of the measures have not produced any deposits at all. This is particularly marked above the Dirty Coal Seam where only one deposit is known occurring in the No. 2 Seam. Another barren zone occurs about midway between the Dirty and Irondale Coal Seams, occupying a depth of strata equivalent to about one-half of the interval between the two coal seams. No deposits have been found in either the upper or lower members of the Marangaroo Beds; but this is to be expected as they consist of sandstone and conglomerate. The thin bed of coal-measures separating the Lower Marangaroo from the Upper Marine has also proved barren, although it contains thin coal seams and fossiliferous shales.

The frequency of occurrence from north-west to south-east, between Ulan and Bowral, is also indicated in Fig. 2. From Ulan to Capertee the deposits occur at fairly regular intervals in both the upper and lower regions of the measures. Further to the south-east, in the vicinity of Katoomba and the Blue Mountains, there is a marked concentration of deposits from the Irondale horizon to the top of the Upper Marangaroo. In the South-Western Coalfield, between Katoomba and Bowral, two of the four deposits occur on the horizon of the Lithgow Seam, and one on each of the Irondale and Dirty Coal Seams. There is no definite relation between the stratigraphical positions of deposits and their distances from the original western margin of the Kamilaroi Basin, or the thickness of the coal-measures.

PALAEOGEOGRAPHICAL DISTRIBUTION OF TORBANITE DEPOSITS IN THE UPPER COAL MEASURES.

Upper Coal Measure sediments were deposited over a fairly wide area in eastern New South Wales, including the Kamilaroi Basin, Oxley Basin and the south-eastern side of the Great Artesian Basin, as illustrated in Fig. 3. Deposition in the Kamilaroi Basin extended a considerable distance to the east of the present coastline. The accompanying geological map (Plate iv) indicates the distribution of upper Kamilaroi sediments, including Upper Marine and Upper Coal Measures of the Kamilaroi Basin, the principal areas in which these beds outcrop, and the location of torbanite deposits. Maps showing the distribution of some of the torbanite deposits have been published by Carne (1903) and Morrison (1929). The isopacks shown along the western margin of the Upper Coal Measures were originally drawn by Dr. H. G. Raggatt in an unpublished D.Sc. thesis (University of Sydney, 1940), and have been reproduced in the present map with his permission. The torbanite deposits occur at frequent intervals in the coal-measures which outcrop along the western and south-western margins of the Kamilaroi Basin between Ulan in the north and Bowral in the south. This feature has been noted by previous writers (Carne, 1903; Morrison, 1929), who have suggested a marginal arrangement of the deposits along the western and south-western sides of the basin. Some doubt has been expressed as to the correctness of this suggestion as the Upper Coal Measures are completely concealed by Triassic sandstone in the central and eastern portions of the basin, and any deposits occurring in these areas would remain unknown.

The following evidence is available concerning the lateral distribution of torbanite deposits in the Upper Coal Measures. Deposits occur throughout the measures of the Western and South-Western Coalfields, being particularly numerous between Katoomba and Rylstone. To the west, these coal-measures thin out and terminate where the basement rocks come to the surface; to the east, the limits of outcrop are determined by the general easterly dip of the strata, which carry the beds beneath the overlying Triassic sandstone. Torbanite deposits occur in the coal-measures from their eroded

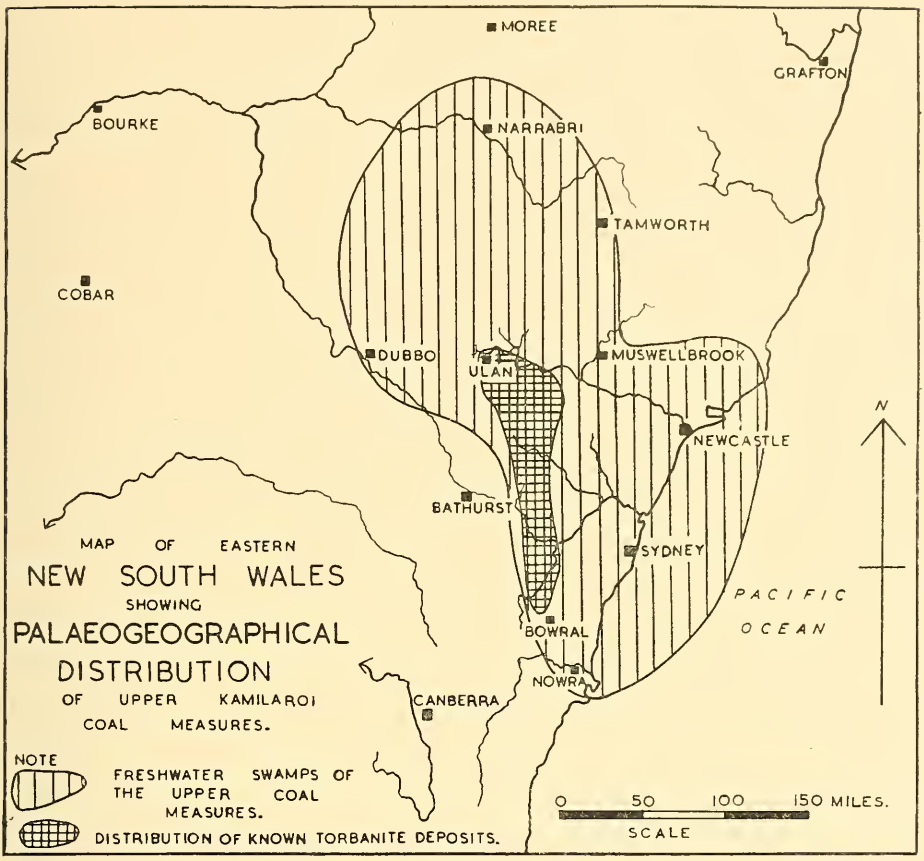

Fig. 3.—Map showing the relation between the distribution of known torbanite deposits and the probable area covered by the freshwater swamps of the Upper Coal Measures.

western edge, as at Ilford and Crown Ridge, to their most easterly points of outcrop where they dip below the Triassic, such as Glen Davis. These coal-measures, varying from 150 to 500 feet in thickness, represent marginal facies of deposition in the Kamilaroi Basin, and the isopacks shown in Plate iv, as well as evidence already discussed by the writer (Dulhunty, 1941*b*), clearly indicate that the present western margin of the measures is roughly parallel to the actual margin of the area in which they were deposited.

On the northern side of the Kamilaroi Basin the valleys of the Goulburn River and its tributaries have dissected the Upper Coal Measures, giving outcrops which run more or less continuously from the Western Coalfield to the Northern or Hunter River Coalfield. Torbanite deposits occur in the coal-measures of the Goulburn Valley from their western margin at Ulan to as far east as Baerami. The fact that no deposits have yet been found between Barigan and Baerami would seem to indicate a decreasing frequency of occurrence as the measures pass to the east. No torbanite has been found in the Upper Coal Measures of the Hunter River Coalfield to the east of Baerami, although there are large areas of outcrop which have been extensively prospected and worked for coal. To the north and north-west of the Goulburn Valley the Upper Coal Measures occur over a wide area; but they are covered, for the most part, by Triassic and Jurassic sediments. Marginal outcrops, however, extend to the vicinity of Dunedoo in the north-west and Gunnedah in the north, but no occurrence of torbanite has been found north of the Goulburn Valley.

At the southern end of the Kamilaroi Basin, the Upper Coal Measures of the Southern Coalfield outcrop along the coast from Coalcliff to the vicinity of Nowra, but do not contain any torbanite deposits. The marginal conditions, typical in the measures of the South-Western Coalfield, where several deposits occur, prevail in the discontinuous outcrops which pass round the southern extremity of the basin to the vicinity of Kangaroo Valley; but the torbanite deposits do not extend any further south than the Reedy Creek occurrence near Joadja.

The absence of torbanite in the Upper Coal Measures of the Hunter River Coalfield indicates that deposits do not occur in the central region of the basin. The measures outcropping along the coast in the Southern Coalfield include sub-central to marginal facies, but do not contain any deposits. These measures are equivalent in a general way to those containing torbanite, which outcrop along the Goulburn Valley between Ulan and Baerami. This suggests that the torbanite deposits extend further towards the centre of the basin in the northern regions of the Western Coalfield than in the South-Western Coalfield. Furthermore, the occurrence of torbanite along the western and south-western sides of the basin is limited to the measures outcropping between Ulan in the north and Bowral in the south. Thus it may be concluded that the development of torbanite, during the deposition of the Upper Coal Measures, was confined to an elongated area trending roughly north-west to south-east, running parallel to the margin of the Kamilaroi Basin, and situated along its western and south-western sides. This area possessed considerable width at its northern end, but gradually narrowed to a point at its southern end in the vicinity of Joadja.

The relation between the area in which torbanite occurs and the palaeogeographical distribution of the Upper Coal Measures in New South Wales is indicated in Figure 3. It is evident that the environmental conditions necessary for the formation of torbanite were present over a comparatively small portion of the total area in which the coal-measures were deposited. Furthermore, these specialized conditions recurred on successive horizons within the limited area to which the development of torbanite was confined. A detailed discussion on the environment of deposition has been reserved for a subsequent paper on the origin of torbanite. It is possible that torbanite may have been formed along the eastern margin of the Kamilaroi Basin, but this cannot be determined as the sediments are submerged by the Pacific Ocean.

The foregoing results suggest that a great deal of torbanite has been removed by erosion along the western margin of the Kamilaroi Basin, between the original shoreline of deposition and the present outcrop of coal-measures. It also follows that torbanite deposits, as yet undiscovered, may exist in the areas concealed by Triassic sandstone immediately to the east of the present lines of outcrop of the coal-measures, particularly in the area between Barigan, Baerami and Glen Davis.

STRATIGRAPHICAL HORIZONS OCCUPIED BY INDIVIDUAL DEPOSITS.

In examining the stratigraphical arrangement of the torbanite deposits an attempt was made to determine, within as narrow limits as possible, the horizon occupied by each. The position relative to the top and the base of the coal-measures was determined, and then coal seams occurring on known horizons were searched for, and the position of the deposit was fixed in relation to the nearest of these. At those places where the torbanite is associated with a coal seam, the horizon of the coal was investigated. In the majority of cases it was possible to determine the position between the two nearest coal-bearing horizons above and below the deposits, or else identify the actual horizon with which the torbanite was associated.

In the following discussion each occurrence is treated separately, and information concerning the situation, thickness and quality of the torbanite is given in each case. When a deposit consists of several bands, the figures given for *total thickness* refer to the aggregate thickness of torbanite excluding bands of foreign material.

The results of proximate analyses are intended to give an idea of the general nature of the torbanite in each deposit rather than in the richest specimen obtainable. References containing relevant data are indicated.

Airly.

Situation: Parishes of Morundurey and Airly, County of Roxburgh.

Maximum thickness of torbanite: 4 feet 9 inches.

Proximate analysis of good sample: Moisture, 0·34%; Volatiles, 54·16%; Fixed Carbon, 23·05%; Ash, 22·45%. (Analysis by Dulhunty.)

Richest material: Moisture, 0·30%; Volatiles, 79·97%; Fixed Carbon, 7·66%; Ash, 12·07%. (Analysis by Dept. Mines, N.S.W.)

References: Carne, 1903; Seaver, 1884.

The deposit known as Airly, or Genowlan, occurs in a large outlier of coal-measures capped with Triassic sandstone on the western side of the Capertee Valley. The deposit outcrops along the northern side of Airly Mountain, where numerous tunnels have been driven. Both the top and base of the coal-measures are exposed at several places, the horizon of the Katoomba Coal Seam is visible, and the lower member of the Marangaroo Beds, underlying the Lithgow Coal Seam, outcrops at the base of the measures.

The torbanite deposit is associated with thin bands of bituminous and cannel coal, but does not occur on any of the major coal-bearing horizons. The coal-measures are 405 feet thick, and the deposit is situated 235 feet from the top and 170 feet above the base. Two small coal seams outcrop between the torbanite deposit and Lithgow Coal Seam, at positions 75 and 110 feet above the latter—the highest being 20 feet below the torbanite. These seams, 35 feet apart, may be equivalent to the upper and lower limits of the Irondale coal-bearing horizon. The horizon of the Dirty Coal Seam is difficult to identify owing to a heavy covering of talus on the upper portion of the measures; but it is certainly above the torbanite deposit, and should be about 80 feet below the Katoomba Seam according to observations made in adjoining localities. Thus it may be concluded that the Airly deposit is situated 130 feet above the Lithgow Seam, and 235 feet below the Katoomba Seam; and it is highly probable that it is 20 feet above the top of the Irondale horizon, and about 155 feet below the Dirty Seam.

Baerami.

Situation: Parish of Caroora, County of Hunter.

Maximum thickness of torbanite: 22 inches.

Proximate analysis of good sample: Moisture, 0·24%; Volatiles, 63·20%; Fixed Carbon, 9·65%; Ash, 26·91%. (Analysis by Emmerton.)

References: Carne, 1919; Kenny, 1939; Morrison, 1929*a*; Morrison and Kenny, 1933.

The main Baerami deposit outcrops in Reuben's Gully, Baerami Arm Creek, and in the valley of Widdin Brook. Reuben's Gully and Baerami Arm Creek form the south-western head waters of Baerami Creek. The seam has been prospected by numerous tunnels, which indicate a deposit of good quality extending over a fairly large area. In Reuben's Gully 345 feet of coal-measure strata are exposed; but this does not represent a full section of the measures.

The torbanite deposit, which is overlain by 20 feet of sandstone and associated with cannel and bituminous coal, outcrops at a position 160 feet below the Triassic. At the top of the coal-measures there is an outcrop of perished coal which represents the Katoomba Seam. Another outcrop of coal which occurs 35 feet below the top seam, may be equivalent to the horizon of the No. 2 Seam outcropping to the south of Mt. Victoria. Two coal seams, 5 and 13 feet in thickness, separated by 17 feet of sandstone, occur at positions 25 and 47 feet above the torbanite deposit. These two seams appear to be the upper and lower splits of the Dirty Coal Seam, which has been identified at several places between Baerami and Wollar. This indicates that the torbanite occupies an horizon approximately 25 feet below the base of the Dirty Seam.

In the valley of Baerami Arm Creek, a little above its junction with Reuben's Gully, a tunnel has been driven on the torbanite seam, which outcrops below the sandstone bed at the horizon described above, and maintains its association with bituminous and cannel coal. Further south towards the head of Baerami Arm Creek, another outcrop has been opened by a short drive, known as Putman's Tunnel. Over

400 feet of coal-measures are exposed in the vicinity of this outcrop, and the torbanite, which is not associated with coal, occurs 370 feet below the base of the Triassic. The sandstone roof is also absent. These facts suggest a second deposit occurring on a lower horizon. This possibility was investigated by obtaining the expansion-volatile relation for specimens from Putman's Tunnel, and also the outcrops from the main deposit in the valleys of both Reuben's Gully and Baerami Arm Creek, in the manner already described by the writer (Dulhunty, 1941). When the specimens were arranged on an expansion-volatile diagram, it was found that those from Putman's Tunnel fell in a separate group, or zone, from those belonging to the main Baerami deposit. It is considered by the author that these results definitely confirm the existence of two separate deposits occurring on different stratigraphical horizons. The exact horizon of the lower seam cannot be determined, as the full thickness of the coal-measures is not exposed in this locality. It is evident, however, that its depth below the top of the measures is a little more than twice that of the main Baerami deposit.

Barigan.

Situation: Portions 39 and 44, Parish of Barigan, County of Phillip.

Maximum thickness of torbanite: 2 feet 6 inches.

Proximate analysis of good sample: Moisture, 0·40%; Volatiles, 59·42%; Fixed Carbon, 10·73%; Ash, 29·45%. (Analysis by Dulhunty.)

References: Carne, 1903; Morrison, 1936; Morrison and Kenny, 1934.

The Barigan deposit is situated in the valley of Derowen Creek, about 15 miles south of the village of Wollar. The deposit has been opened by shafts and drives on the western side of Derowen Creek. The seam is associated with 3 feet of bituminous and stony coal. The outcrop is poorly defined as it is situated near the floor of the valley, and obscured by a thick covering of soil. At several places a bed of sandstone outcrops immediately below the horizon of the torbanite, and there is evidence of another sandstone bed lying a few feet above the deposit. Upper Marine strata occur beneath the lower sandstone bed, which forms the lower member of the Marangaroo; and the coal associated with the torbanite corresponds to the horizon of the Lithgow Coal Seam, while the upper sandstone bed represents the Upper Marangaroo. Therefore the Barigan torbanite deposit occurs on the horizon of the Lithgow Coal Seam.

Blackman's Crown or Crown Ridge.

Situation: Mining Portion 2, Parish of Bandamora, County of Roxburgh.

Maximum thickness of torbanite: About 4 feet.

Proximate analysis of good sample: Moisture, 0·50%; Volatiles, 60·65%; Fixed Carbon, 16·20%; Ash, 22·65%. (Analysis by Dept. Mines, N.S.W.)

Reference: Carne, 1903.

This deposit is situated on the Main Divide, 1½ miles south-east from Capertee, and occurs in a small outlier of coal-measures and Triassic sandstone.

It has been opened at numerous places by prospecting trenches and short drives. It is a complex deposit consisting of several seams interbedded with bituminous and cannel coal and carbonaceous shale. The quality is very variable, but a small portion of the seam, up to 12 inches in thickness, is of high grade material. At Blackman's Crown the coal-measures are 355 feet thick. The horizon of the Katoomba Coal Seam is marked by coaly bands occurring a few feet below the base of the Triassic sandstone cliffs. The torbanite is associated with coal at a position 60 feet below the Katoomba Seam. The Lithgow Seam, at the base of the coal-measures, occurs 10 feet above the Lower Marangaroo Conglomerate, which is 65 feet thick, forming a prominent line of cliffs. A three-foot seam of coal, which evidently represents the Irondale horizon, occurs about 60 feet above the Lithgow Seam. No coal of any consequence can be seen between this position and the torbanite deposit. It may be concluded, therefore, that the torbanite occurs on the horizon of the Dirty Coal Seam, 60 feet below the Katoomba horizon, and 155 feet above the Irondale horizon.

Bonnum Pic or Paddy's Peak.

Situation: Portion 59, Parish of Nattai, County of Camden.

Maximum thickness of torbanite: 3½ inches.

Proximate analysis of good sample: Moisture, 1·20%; Volatiles, 39·02%; Fixed Carbon, 24·71%; Ash, 35·07%. (Analysis by Dept. Mines, N.S.W.)

Reference: Carne, 1903.

The position of this deposit was recorded by J. E. Carne (1903), but as yet the author has not been able to discover the outcrop to determine the stratigraphical horizon. The deposit appears to be of no economic importance.

Coolaway Mountain.

Situation: Parish of Burrowoury, County of Roxburgh.

Maximum thickness of torbanite so far exposed: 1 foot 3 inches.

Analysis of good sample: Moisture, 0·12%; Volatiles, 77·30%; Fixed Carbon, 17·35%; Ash, 5·23%. (Analysis by Emmerton.)

Reference: Morrison and Kenny, 1932.

Coolaway Mountain is situated on the southern side of the Cudgegong Valley about 8 miles south-east of Rylstone. The torbanite deposit outcrops near the base of the mountain on its northern side, where the slope of the hill is very low, and consequently the outcrop is almost completely obscured by a thick covering of soil. Several prospecting shafts have been put down at intervals between the outcrop and the mountain side. These shafts established 1 foot 3 inches of torbanite, but the thickness increases as the deposit passes south under Coolaway Mountain. The true extent and maximum thickness of this deposit have not yet been revealed. The torbanite is of remarkably high quality, certain portions of the seam yielding over 200 gallons of crude oil per ton. This constitutes the richest known torbanite in Australia, and probably in any part of the world.

The position of the outcrop indicates that the deposit is situated low down in the coal-measures; and it was suggested by Kenny and Morrison (1932) that it is within 100 feet of the base. The Marangaroo Beds and Lithgow Coal Seam have been followed by the author from the Capertee Valley to the Cudgegong Valley, where they form a small but distinct topographical feature on the undulating valley floor near Coolaway Mountain. Weathered blocks of torbanite are associated with the two beds of sandstone forming this feature a little to the north of the prospect shafts, which intersect the deposit at about the same level as the outcrop of the Marangaroo Beds. The seam, as exposed in the shafts, is associated with coal and carbonaceous shale, and occurs a few feet below a bed of sandstone, which evidently represents the Upper Marangaroo. These facts suggest that the deposit occurs on the horizon of the Lithgow Coal Seam between the upper and lower member of the Marangaroo Beds.

Cooyal Creek.

The occurrence of torbanite near the head of Cooyal Creek has been unofficially reported; and the author has found a considerable quantity of drift material in the creek above the village of Cooyal, which confirms the occurrence. The torbanite appears to be all low grade material, and the actual outcrop has not been examined for the purpose of determining the stratigraphical position which it occupies.

The occurrence of drift blocks of torbanite in the Tertiary Deep Leads at Gulgong was reported by C. S. Wilkinson (1877). It is evident that these blocks came from the deposit near the head of Cooyal Creek.

Glen Davis-Newnes.

Situation: Parishes of Capertee and Glen Alice, County of Hunter; Parish of Gindantherie, County of Cook.

Maximum thickness of torbanite: 4 feet 3 inches.

Proximate analysis of good sample: Moisture, 0·20%; Volatiles, 63·55%; Fixed Carbon, 12·95%; Ash, 23·30%. (Analysis by Dept. Mines, N.S.W.)

References: Carne, 1903; Morrison, 1929*a*.

The torbanite deposit, which is being developed by National Oil Pty. Ltd. at Glen Davis, outcrops in both the Capertee and Wolgan Valleys. The deposit extends over a large area representing one of the most extensive and valuable deposits known to occur in the Kamilaroi Basin. Full sections of the coal-measures cannot be obtained at Newnes in the Wolgan Valley, as the base of the measures is below the river level; but a complete section is exposed in the Capertee Valley in the vicinity of Green's Gully on the north-western side of the deposit. This section was originally measured and recorded by J. E. Carne. The torbanite deposit occurs 250 feet above the Lithgow Seam, and 212 feet below the Dirty Seam, while the coal-measures possess a total thickness of 535 feet. A well-defined coal-bearing horizon, known locally as the Wolgan Seam, occurs 60 feet below the torbanite, and about 200 feet above the base of the measures. It has been suggested that this may be equivalent to the Irondale horizon, which seems possible, although its position in the coal-measures is a little too high to permit of a definite conclusion being reached. Apart from its proximity to the Wolgan Seam, the horizon of the torbanite cannot be ascertained beyond its relative position between the Lithgow and Dirty Coal Seams.

Grimshaw's Seam.

Situation: Parish of Umbiella, County of Roxburgh.

Maximum thickness of torbanite: Probably less than 12 inches.

Quality: Low to medium grade torbanite.

Reference: Carne, 1903.

This deposit outcrops on the northern side of the valley of Capertee Nile Creek, immediately to the south of Tayan Pic. It has not been opened up or prospected, as the quality of the torbanite is low—talus blocks, however, indicate a thickness of less than 12 inches. The coal-measures are 545 feet thick in the vicinity of the deposit. An excellent exposure of the Katoomba Coal Seam occurs above the outcrop of the torbanite, amounting to 10 feet of good coal and bands. The torbanite deposit is associated with at least 4 feet of coal at a position 110 feet below the Katoomba Seam. There is no definite evidence of coal between the two, and it seems highly probable that the torbanite occurs on the horizon of the Dirty Coal Seam. The interval between the Katoomba and Dirty horizons is not unduly large considering the thickness of the coal-measures, which is considerably greater than their average thickness along the western margin of the basin.

Hartley Vale.

Situation: Parish of Lett, County of Cook.

Maximum thickness of torbanite: Originally about 5 feet.

Proximate analysis of good sample: Moisture, 0·55%; Volatiles, 77·14%; Fixed Carbon, 6·60%; Ash, 15·71%. (Analysis by Dulhunty.)

References: Carne, 1903; David, 1896; Morrison, 1929*a*.

The Hartley Vale deposit, which was the first discovery of torbanite in New South Wales (about 1825), was worked extensively from about 1866 till 1900. The old workings have now collapsed; but it is believed that most of the available high grade material has been worked out. The torbanite was of particularly high quality, and the seam attained a maximum thickness of 5 feet.

The exact stratigraphical position of the deposit is difficult to determine as the outcrop occurs only a few feet above the level of the valley floor, and the area has been subjected to faulting. Carne indicated that the horizon was about 60 feet above the Marangaroo Conglomerate. The base of the coal-measures outcrops about 40 chains to the south of the old workings, where the upper member of the Marangaroo, overlying the Lithgow Coal Seam, is exposed. The coal-measures are about 400 feet thick in the vicinity of Hartley Vale, and the strata dip to the north-east at a low angle. The outcrop of the deposit was calculated to be 280 feet below the Katoomba Coal Seam, which is exposed at the base of the Triassic sandstone, and 100 feet above the Lithgow Seam, which is 20 feet from the base of the measures. The horizon of the deposit must be close to the Irondale Coal Seam; but the torbanite is not directly associated with

coal seams of any consequence. Thus its position would appear to be close above the horizon of the Irondale Coal Seam, rather than actually associated with it.

Ilford Range.

Situation: Parish of Hearne, County of Roxburgh.

Maximum thickness of torbanite: 2 feet 6 inches.

Proximate analysis of good sample: Moisture, 0·87%; Volatiles, 36·60%; Fixed Carbon, 11·26%; Ash, 51·27%. (Analysis by Dept. Mines, N.S.W.)

This deposit is situated on the north-eastern side of the Ilford Range about 4½ miles south from Clandulla. The deposit has been prospected by tunnels and trenches, and exhibits a maximum thickness of 14 inches. It occurs 25 feet below the top of the coal-measures at the base of a coal-bearing horizon, which is separated from the Katoomba Seam by 5 to 10 feet of white chert and shales. It is believed that the horizon of the torbanite and associated shales is that of the No. 2 Coal Seam, although there is a possibility that it may represent a lower split of the Katoomba Seam. The coal-measures are about 300 feet thick in the vicinity of the Ilford deposit.

Joadja.

Situation: Parish of Joadja, County of Camden.

Maximum thickness of torbanite: Originally 4 feet; material now available: 1 foot 6 inches.

Proximate analysis of good sample: (*a*) Best grade from original 4 foot seam: Moisture, 0·12%; Volatiles, 77·36%; Fixed Carbon, 17·82%; Ash, 4·70%. (*b*) From 18 inches now available: Moisture, 1·85%; Volatiles, 52·80%; Fixed Carbon, 21·33%; Ash, 24·02%. (Analyses (*a*) by Emmerton; (*b*) No. 3082 by Dept. Mines, N.S.W.)

References: Carne, 1903; Morrison, 1922.

The Joadja deposit outcrops on both sides of the valley of Joadja Creek, about four miles above its junction with the Wingecarribee River. The thickest and richest portions of the deposit have been worked out, only the fringes now remaining beyond the old workings.

The deposit occurs beneath a thick bed of sandstone, near the base of the coal-measures. It is associated with about 4 feet of bituminous and cannel coal, and is situated 12 to 15 feet above the Lithgow Coal Seam, which is 5 feet in thickness and is separated from the bituminous and cannel coal by laminated sandstone. The coal-measures are about 150 feet thick, and the Dirty Coal Seam outcrops strongly a little below the base of the Triassic sandstone. The beds above the Dirty Seam are absent in this locality (Dulhunty, 1941*b*). The Irondale coal-bearing horizon is not clearly defined in the Joadja Valley, and it has been suggested that the coal with which the torbanite is associated may be on this horizon. It seems more probable, however, that it is the upper portion of the Lithgow Coal Seam, separated from the lower portion by laminated sandstone which causes a split in the seam, especially in view of the fact that the Lithgow horizon attains a thickness of 15 feet in the valley of Reedy Creek about 4 miles to the south-east. Thus it has been assumed tentatively that the Joadja deposit occurs at the top of the Lithgow coal-bearing horizon.

Katoomba.

Situation: Parish of Megalong, County of Cook.

References: Carne, 1903; David, 1891.

(I) *Mort's Lower Seam.* Megalong Valley.

Maximum thickness of torbanite: 1 foot 1 inch.

Proximate analysis of good sample: Moisture, 0·30%; Volatiles, 74·10%; Fixed Carbon, 13·08%; Ash, 12·52%. (Analysis by Dept. of Mines, N.S.W.)

(II) *Mort's Upper Seam.* Megalong Valley.

Maximum thickness: 8 inches.

Proximate analysis of good sample: Moisture, 1·65%; Volatiles, 51·00%; Fixed Carbon, 33·60%; Ash, 13·75%. (Analysis by Dept. Mines, N.S.W.)

(III) *Ruined Castle Seam.* Jamieson Valley.

Maximum thickness of torbanite: 1 foot 2 inches.

Proximate analysis of good sample: Moisture, 0·45%; Volatiles, 77·57%; Fixed Carbon, 12·73%; Ash, 9·25%. (Analysis by Dept. Mines, N.S.W.)

Three seams of torbanite occur in the coal-measures underlying Narrow Neck Range, which runs south from Katoomba between the headwaters of the Megalong and Jamieson Valleys. Two of the deposits, known as Mort's Upper and Lower Seams, outcrop on the western side of the range, while the third, known as the Ruined Castle Seam, outcrops mainly on the eastern side, and at one place on the western side. The margin of Mort's Upper Seam has been opened on the western side of Megalong Creek at the west head of Nelly's Glen, where the author has also located the fringing edge of Mort's Lower Seam. The three seams were thoroughly prospected along either side of Narrow Neck Range. Mort's Upper Seam and the Ruined Castle Seam have both been worked for commercial purposes. They contain high quality torbanite, but are limited in thickness. Mort's Lower Seam is of little value as it is very thin and consists of medium to low grade material.

It was known that the three seams occurred near the base of the coal-measures; but the exact horizons which they occupied had not been clearly defined. The following section, illustrating the relative positions of the three seams, was obtained at the southern extremity of the old workings on the Megalong side of Narrow Neck. The Ruined Castle Seam is not present in this section; but its horizon was determined at the northern end of the workings where it outcrops above Mort's Upper Seam:

4 feet	shaly sandstone.
2 inches	cannel coal.
5 „	torbanite. RUINED CASTLE SEAM.
1 inch	semi-bituminous coal.
2 feet	soft carbonaceous shale.
37 „	coal-measure shales and sandstone bands.
5 „	laminated sandstone.
15 inches	carbonaceous shale.
4 „	bright coal.
12 „	torbanite. MORT'S UPPER SEAM.
6 „	dirty coal.
2 feet	carbonaceous shaly mudstone.
10 „	carbonaceous shale and sandstone bands.
7 inches	bright coal.
2 feet	carbonaceous shaly mudstone.
8 inches	torbanite. MORT'S LOWER SEAM.
3 feet	dirty coal.
2 „	grey sandy shale.
16 inches	bright and dirty coal.
3 feet	blue carbonaceous mudstone.
8 „	quartz-pebble conglomerate. UPPER MARANGAROO.
4 inches	bright coal. LITHGOW COAL SEAM.
3 feet	clay shale and shaly sandstone.
6 feet	quartz-pebble conglomerate. LOWER MARANGAROO.
2 „	soft laminated sandstone.

Mort's Lower Seam is associated with bands of coal and carbonaceous shale, which frequently occur immediately above the upper member of the Marangaroo Conglomerate. This horizon is not equivalent to any of the recognized coal seams of the Western Coalfield; but it is fairly persistent, and has been recognized in several districts (Dulhunty, 1941). Mort's Upper Seam, 21 feet above the lower seam and about 30 feet above the upper member of the Marangaroo, is also associated with coal and highly carbonaceous shale. This horizon is too low in the coal-measures to be equivalent to the Irondale Seam; and it probably represents a local development of coal resulting from the conditions favouring the formation of torbanite, although it is possible that it may be an upper split of the coal-bearing beds lying on the upper member of the Marangaroo Conglomerate.

The relative position of the Ruined Castle Seam strongly suggests that it occurs a little above the horizon of the Irondale Coal Seam, approximately 46 feet above Mort's Upper Seam, and 88 feet above the Lithgow Seam.

Lamb's Seam, Wolgan Valley.

Situation: Parish of Gindantherie, County of Cook.

Maximum thickness of torbanite: 12 inches.

Proximate analysis of good sample: Moisture, 1·05%; Volatiles, 53·92%; Fixed Carbon, 11·51%; Ash, 33·52%. (Analysis by Dept. Mines, N.S.W.)

Reference: Carne, 1903.

The seam outcrops on the western side of the Wolgan Valley, about 1½ miles north-west from Mount Wolgan. It has been opened by several short prospecting tunnels, but does not exceed 12 inches in thickness. The lower member of the Marangaroo, underlying the Lithgow Coal Seam, outcrops about 8 feet above the Upper Marine and 15 feet below the torbanite deposit. There is no evidence of the Upper Marangaroo, and it may be concluded that the torbanite occurs about 10 feet above the Lithgow Coal Seam, and close above the horizon of the upper member of the Marangaroo. The coal-measures are 425 feet thick in this part of the Wolgan Valley.

Marangaroo.

Situation: Parishes of Marangaroo, Lidsdale and Blackheath, County of Cook.

Maximum thickness of torbanite: Medium quality, 2 feet; very low grade, 3 feet.

Proximate analysis of good sample: Moisture, 0·95%; Volatiles, 44·60%; Fixed Carbon, 7·75%; Ash, 46·70%. (Analysis by Dept. Mines, N.S.W.)

References: Carne, 1903; Mackenzie, 1887.

The Marangaroo deposit outcrops along both sides of Middle Creek Range in the vicinity of the Marangaroo railway tunnel between Marangaroo Siding and Wallerawang. The deposit was developed for commercial purposes as early as 1867. The torbanite occurs in the form of large lenses associated with the Dirty Coal Seam over an area of about three square miles. Some of the lenses possess a thickness of about 2 feet of medium quality torbanite, but the majority are less than 18 inches.

The Dirty Seam occurs 70 feet below the base of the Triassic sandstone 245 feet above the Lithgow Seam, and 312 feet above the base of the coal-measures. The horizon of the Katoomba Seam is indicated by coaly bands and carbonaceous shales, about 10 feet below the base of the Triassic sandstone.

Mornington.

Situation: Parish of Clandulla, County of Roxburgh.

Maximum thickness of torbanite: about 12 inches.

Proximate analysis of best sample: Moisture, 0·89%; Volatiles, 33·14%; Fixed Carbon, 7·12%; Ash, 58·85%. (Analysis by Dulhunty.)

Reference: Carne, 1903.

The Mornington deposit outcrops on both sides of the Main Dividing Range about 3 miles east from Clandulla. The torbanite is low grade, and the seam attains a maximum thickness of 12 inches.

The coal-measures are 330 feet thick in the vicinity of the deposit. The Katoomba Coal Seam is exposed at the top of the coal-measures, and the Lithgow Coal Seam and lower member of the Marangaroo Beds outcrop at the base of the coal-measures. There is no coal of any consequence associated with the torbanite deposit which occurs 106 feet below the top of the Katoomba Coal Seam and 215 feet above the Lithgow Seam. The horizons of the Dirty and Irondale Coal Seams are difficult to identify in the vicinity of the deposit; but the former should occur about 70 feet below the top of the Katoomba Seam. It is evident that the torbanite is not associated with any of the major coal-bearing horizons, and its stratigraphical position appears to be approximately 35 feet below the horizon of the Dirty Coal Seam.

Mount Blackheath.

Situation: Parish of Kanimbla, County of Cook.

Maximum thickness of torbanite: 3 inches.

Proximate analysis of good sample: Moisture, 0·55%; Volatiles, 66·65%; Fixed Carbon, 6·53%; Ash, 26·27%. (Analysis by Dept. Mines, N.S.W.)

References: Bertrand, 1900; Carne, 1903.

The deposit outcrops on the western escarpment of Mount Blackheath about three miles south-west from the township of Blackheath. The seam was prospected by trenches at intervals along the mountain side, but it proved too thin to justify further development. The coal-measures are 257 feet thick and the Katoomba Seam, Marangaroo Beds and Lithgow Seam are exposed at several places. The torbanite, which is not associated with any of the coal seams, occurs 37 feet above the Lithgow Seam, and 27 feet above the top of the upper member of the Marangaroo. It is interesting to note that this deposit occupies the same horizon as Mort's Upper Seam in the Megalong Valley, which is four and a half miles away to the south-east; but there is no evidence of the two deposits being continuous.

Mount Marsden.

Situation: Parish of Goongal, County of Roxburgh.

Maximum thickness of torbanite: 7 inches.

Proximate analysis of good sample: Moisture, 0·72%; Volatiles, 58·15%; Fixed Carbon, 15·43%; Ash, 25·70%. (Analysis by Dept. Mines, N.S.W.)

Reference: Carne, 1903.

The deposit outcrops along the southern slopes of Mount Marsden on the northern side of the Capertee Valley. The seam was opened at several places by prospecting trenches, but has not been developed owing to limited thickness, although the torbanite is of reasonably high quality. It is associated with the Marangaroo Beds at the base of the coal-measures occurring in the Lithgow Coal Seam, below the upper member of the Marangaroo. The horizon of the seam is the same as that occupied by the Coolaway Mountain deposit, which is situated about 4 miles away to the north; but there is no evidence of any continuity between the two.

Mount Tonalli.

Situation: Parish of Wingecarribee, County of Westmoreland.

Maximum thickness of torbanite: Medium quality, 1 foot 9 inches; low grade, 14 inches.

Proximate analysis of good sample: Moisture, 0·58%; Volatiles, 62·94%; Fixed Carbon, 7·02%; Ash, 29·46%. (Analysis by Emmerton.)

References: Carne, 1903; Morrison and Kenny, 1932.

The deposit, which outcrops along the southern escarpment of Mount Tonalli, has been opened by a prospecting tunnel near the south-eastern corner of Mining Lease 2, Parish of Wingecarribee. The torbanite, which is associated with coal, outcrops at a position 120 feet below the base of the Triassic sandstone, but the upper portion of the coal-measures is completely covered by talus debris. The nearest exposure of the coal-measures is in Higgins' Creek, 1 mile to the north-east of the prospecting tunnel. In this section three coal seams are exposed at 20, 45 and 125 feet below the Triassic sandstone. It is evident that the torbanite is associated with the lowest of these three seams, although it is not present in the section. The highest seam, consisting of two feet of good coal, represents the No. 1, or Katoomba horizon; and it was suggested by Morrison and Kenny (1932) that the two lower seams may represent upper and lower splits of the No. 3, or Dirty Seam. On the opposite side of the Burragorang Valley, and also in the vicinity of Lower Burragorang, the No. 2 Coal Seam of the Southern Coalfield outcrops between the Top Seam and the Dirty Seam. Thus it would appear possible that the second seam exposed in Higgins' Creek may also be the No. 2 Coal Seam rather than an upper split of the Dirty Seam. In either case the torbanite deposit is associated with the Dirty Seam, at a position about 105 feet below the Katoomba horizon, and 230 feet above the Lithgow Seam.

Reedy Creek.

Situation: Mining Reserve No. 41188, Parish of Joadja, County of Camden.

Maximum thickness of torbanite: 10 inches.

Proximate analysis of good sample: Moisture, 0·27%; Volatiles, 57·38%; Fixed Carbon, 13·20%; Ash, 29·15%. (Analysis No. 3089 by Dept. Mines, N.S.W.)

References: Morrison, 1922; Morrison and Kenny, 1931.

This deposit outcrops on the western side of the valley of Reedy Creek, about four and a half miles south-east from Joadja. The coal-measures are 140 feet thick, and the outcrop, which consists of two thin bands of torbanite separated by cannel coal, occurs in the lowest coal seam, the Lithgow Seam, which lies directly on the lower member of the Marangaroo Conglomerate. The horizon of this seam occupies from 10 to 14 feet of strata, and the lower member of the Marangaroo is about 20 feet in thickness, forming a well-defined line of low cliffs along the sides of the valley.

Sugar Loaf Mountain.

Situation: Parish of Hartley, County of Cook.

Maximum thickness of torbanite: 12 inches.

Proximate analysis of good sample: Moisture, 0·75%; Volatiles, 59·51%; Fixed Carbon, 19·12%; Ash, 20·62%. (Analysis by Dulhunty.)

References: Carne, 1903; Mackenzie, 1887.

This deposit outcrops at Sugar Loaf Mountain, one and a half miles south-west from the village of Mount Victoria. The torbanite is of good quality, but its limited thickness detracts from the value of the deposit. The coal-measures are 390 feet thick, and the torbanite, which is not associated with coal, occurs 90 feet above the Lithgow Seam. The Irondale Seam is indefinite at Sugar Loaf Mountain, but its horizon must be close above the torbanite deposit. The Dirty Coal Seam occurs 60 feet below the Katoomba Seam, and 235 feet above the torbanite. It has been concluded that the position of the torbanite is 90 feet above the Lithgow Seam, and 15 to 20 feet below the Irondale Seam.

Tong Bong Mountain.

Situation: Parish of Louee, County of Phillip.

Maximum thickness of torbanite: 10 inches.

Proximate analysis of good sample: Moisture, 0·43%; Volatiles, 46·33%; Fixed Carbon, 10·62%; Ash, 42·62%. (Analysis by Dulhunty.)

Reference: Morrison, 1929*a*.

Tong Bong Mountain is situated near the Mudgee railway line between Rylstone and Lue. The deposit outcrops on the northern side of the mountain, where it has been opened by two short prospecting tunnels. The mountain is capped by a denuded dolerite sill intrusive into the Triassic in the vicinity of the deposit. The coal-measures are 240 feet thick, and the Katoomba Coal Seam is represented by 8 feet of coal and bands, 2 feet below the Triassic sandstone. The horizon of the Dirty Coal Seam, 70 feet below the Katoomba horizon, is occupied by 10 feet of carbonaceous shale and coaly bands. At the base of the coal-measures, a white, coarse-grained sandstone occurs about 15 feet above the Upper Marine, and 10 feet below a coal seam, which evidently represents the Lithgow horizon. Fifty feet above this seam, and 15 feet below the torbanite seam, there occurs an outcrop of perished coal and bands which appears to be the Irondale horizon. Thus it has been concluded that the horizon of the torbanite is situated 70 feet below the Dirty Seam, and 15 feet above the Irondale horizon.

Ulan.

Situation: Portion 9, Parish of Ulan, County of Bligh.

Maximum thickness of torbanite: 10 inches.

Proximate analysis of good sample: Moisture, 0·85%; Volatiles, 74·73%; Fixed Carbon, 8·72%; Ash, 15·70%. (Analysis by Dulhunty.)

Reference: Carne, 1903.

The Ulan deposit is situated near the junction of Ulan Creek with the Goulburn River, about 3½ miles north of the village of Ulan. The seam has been opened by several prospecting shafts. The torbanite is associated with about 2 feet of dirty coal; but the stratigraphical position of the deposit is difficult to determine, as the outcrop occurs at river level in a large alluvial flat, where sections of the underlying coal-measures are not available. About two miles to the south, however, a full section of the measures.

250 feet in thickness, is exposed in the vicinity of the Ulan Coal Mine, where the Lithgow Coal Seam occurs between the upper and lower members of the Marangaroo. A bed of coaly material occupying a position 35 feet above the top of the Upper Marangaroo, and 140 feet below the top of the measures, appears to represent the horizon of the torbanite deposit, when the dip of the strata to the north-east, and the elevation of the deposit, are taken into consideration.

It seems probable that this horizon is situated between the Upper Marangaroo and the Irondale coal-bearing horizon, as it occurs too low in the coal-measures to be considered equivalent to the latter. The Katoomba and Dirty Coal Seams have not been identified in the vicinity of the torbanite deposit.

Victoria Falls.

Situation: Mining Leases 11 and 12, Parish of Blackheath, County of Cook.

Maximum thickness of torbanite: 4 inches.

Proximate analysis of good sample: Moisture, 0·87%; Volatiles, 44·85%; Fixed Carbon, 19·48%; Ash, 34·80%. (Analysis No. 112, by Dept. Mines, N.S.W.)

Reference: Carne, 1903.

The deposit outcrops immediately to the north of Victoria Falls, on the south-western side of the Grose Valley, 3½ miles north-east of Mount Victoria. Several short prospecting tunnels were originally driven on the seam, but these are not now available, and the outcrop, for the most part, is obscured by a heavy covering of talus. The coal-measures are 420 feet thick, and the upper member of the Marangaroo, overlying the Lithgow Coal Seam, outcrops a little above the level of the Victoria Falls. The position of the torbanite deposit is indicated by weathered blocks at several places where recent slides have occurred in the talus debris, and its stratigraphical position would appear to be about 90 feet above the upper member of the Marangaroo, and 300 feet below the Katoomba Coal Seam. This deposit evidently occurs on approximately the same horizon as that occupied by both the Hartley Vale and Sugar Loaf deposits.

Wanganderry.

Situation: Parish of Wanganderry, County of Camden.

Maximum thickness of seam: 14 inches.

Proximate analysis of good sample: Moisture, 0·46%; Volatiles, 37·88%; Fixed Carbon, 14·73%; Ash, 46·93%. (Analysis by Lambeth.)

The deposit, which outcrops on Wilson's Creek, about 4 miles above its junction with the Nattai River, was discovered in 1941 by A. J. Lambeth, who determined its stratigraphical position, and supplied the following data, which have been confirmed by the author: The coal-measures, containing three coal-bearing horizons, are 185 feet thick in this locality. The No. 3, or Dirty Seam, is situated about 10 feet below the Triassic sandstone, and the No. 7, or Lithgow horizon, occurs immediately above the lower member of the Marangaroo, at the base of the measures. The third coal-bearing horizon, considered to be equivalent to the No. 6, or Irondale Seam, occurs 60 feet below the Dirty Seam. The torbanite, which is associated with cannel coal and carbonaceous mudstone, occurs on the Irondale horizon.

Wollar.

Situation: Parish of Wollar, County of Comiala.

Maximum thickness of torbanite: 3 feet.

Proximate analysis of good sample: Moisture, 0·80%; Volatiles, 45·79%; Fixed Carbon, 14·42%; Ash, 38·99%. (Analysis by Dulhunty.)

References: Jones, 1926; Morrison, 1929*b*; Morrison, 1936.

The Wollar deposit occurs in the coal-measures underlying an outlier of Triassic sandstone on the northern side of the Sandy Hollow–Maryvale railway line, 3 miles north-west of the village of Wollar. It has been prospected by numerous trenches and a tunnel on the eastern side of the deposit. The coal-measures are 395 feet thick, and the Katoomba Coal Seam is represented by dirty, coaly and carbonaceous shale occurring immediately below the Triassic sandstone. The torbanite deposit, associated with cannel and bituminous coal, occurs beneath a bed of soft tuffaceous sandstone 20 feet in

thickness, and is situated 50 feet below the Katoomba horizon. There is no evidence of coal for some distance below the torbanite, thus it may be concluded that the deposit occurs on the horizon of the Dirty Coal Seam.

Wondo or Cottage Rock.

Situation: Portions 1 and 52, Parish of Glen Alice, County of Roxburgh.

Maximum thickness of torbanite: 10 inches.

Proximate analysis of good sample: Moisture, 0·17%; Volatiles, 70·23%; Fixed Carbon, 18·09%; Ash, 11·51%. (Analysis by Emmerton.)

Reference: Carne, 1903.

The Wondo deposit outcrops on the western side of the valley of Umbiella Creek at its junction with the Capertee Valley. The torbanite outcrops near the base of the coal-measures, which are 500 feet thick in this locality. The Lithgow Coal Seam and Lower Marangaroo are exposed at several places along the mountain side, although their outcrop is largely obscured by talus. The position of the torbanite deposit is about 35 feet above the Lithgow Coal Seam, and 65 feet above the base of the measures.

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